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# The Effect of the "Shuttle Time" Program on the Physical and Technical Training of Badminton Athletes

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**ABSTRACT**

**Background:** To achieve high sports results, specialists must consistently search for effective strategies and methods of improving badminton players' physical condition and technical skills. **Objective:** Considering the urgency of the problem and personal sports experience, the work aimed to investigate the effectiveness of the Asian program "Shuttle Time" as an influence on the physical and technical training of students – badminton players of high sportsmanship. **Methodology:** This randomized controlled trial study involved 40 students in their 1st to 4th years of specializing in badminton (ages 18-22). The study subjects were divided into 2 groups – experimental (n=20) and control (n=20). The experimental group followed the "Shuttle Time" program, which included general physical training, special physical training, and technical and tactical exercises, gradually increasing in complexity and focusing on coordination, stability, balance, speed, and reaction. The control group trained according to the university's sports development group program, focusing mainly on improving physical qualities. Technical training for both groups was assessed using four tests: performing a "Smash" shot on two targets from one point, executing a "Short shot" on two targets, executing a "Smash" shot in a straight line to the target from a fixed position, and performing a "Short" shot in a straight line to the target from a fixed position on each side of the court. The physical fitness of participants was evaluated through a series of tests, including a 20-m run, running 9.13-36.6-45.7-55 m (10-40-50-60 yd), standing long jump, high jump from a standing position, 3x10 m shuttle run, hexagon jumps for agility, and the Badcamp test. For reliability, the indicators of the study were processed using methods of mathematical statistics, including the calculation of arithmetic means (X) and standard deviations (S), and the application of Student's t-test to determine the significance of changes in the results between the first and subsequent tests. The results of the study were processed by calculating arithmetic means (X) and their standard deviations (S), and the significance of changes in the results was determined using Student's t-test, with a difference considered significant when $p<0.05$. **Results:** These studies showed statistically significant changes in physical fitness indicators and in comparison, group. Among the statistically reliable improvements in physical fitness indicators, the most significant was the increase in running speed during the 55 m distance, covering sections of this distance from 9.13 to 36.6 m, from 36.6 to 45.7 and from 45.7 to 55 m ($p<0.01$). The improvement in the technical readiness of the studied experimental group was more significant compared to the control group and statistically significant ($p<0.05$). **Conclusion:** Thus, the application of the "Shuttle Time" program makes it possible to objectively improve the physical and technical fitness of badminton players. Modernization of the training process using the Asian program significantly increased fitness by the end of the experimental study.

**Key words:** Physical Fitness, Sports, Skills, Athletic Performance, Educational Measurement

## INTRODUCTION

Badminton is a sport that requires the player to have different physical qualities and complex motor skills (Kyrychenko & Pivovar, 2023a). Badminton players must be able to run fast, stop abruptly and reverse direction, jump high, and maintain good balance when performing movements. Consequently,

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badminton players, who are focused on improving their physical and technical qualities, must constantly look for new methods and means to improve and maintain their skills and fitness while achieving the highest sports results. Speed or speed abilities is one of the most important qualities when practicing badminton. Speed is characterized as the ability to perform motor actions in the minimum period of time for given conditions. The speed of performing motor skills in badminton plays a significant role (Kyrychenko & Pivovar, 2023b).

Recent research has explored various training methods to enhance badminton athletes' physical and technical performance. Iqbal et al. (2024) conducted a systematic review on optimizing agility training, highlighting its importance in improving players' movement and reaction times. They found that agility training significantly enhances players' performance by improving their ability to change direction quickly and efficiently. Ding and Wang (2023) examined the effects of compound training on physical fitness, demonstrating significant improvements in strength, endurance, and overall athletic performance. Their study emphasized the benefits of combining different types of exercises to create a comprehensive training program that addresses multiple fitness components simultaneously. Kuo et al. (2022) investigated the impact of a visual reaction training system on badminton players' performance, showing that such training can significantly improve players' reaction times and accuracy. This study provided evidence that integrating visual and cognitive training with physical exercises can enhance overall performance. Liu et al. (2021) explored the benefits of an eight-week sprint interval training program on the aerobic performance of elite badminton players, finding significant improvements in their cardiovascular fitness and endurance. The study highlighted the importance of high-intensity interval training in enhancing aerobic capacity and overall athletic performance.

Xu et al. (2021) examined the cognitive characteristics of skilled badminton players, emphasizing the mental attributes necessary for high-level performance. They found that cognitive skills such as decision-making, spatial awareness, and tactical thinking are crucial for success in badminton. Nugroho et al. (2021) evaluated the effects of intensity and interval levels in circuit training on the physical condition of badminton players, presenting evidence that such training can significantly improve strength, agility, and endurance. Their study supported the idea that varying the intensity and intervals of exercises can lead to more effective training outcomes. Duncan et al. (2021) analyzed the effects of the BWF Shuttle Time Program on children's fundamental movement skills, revealing significant improvements in both actual and perceived competence. The study demonstrated that structured training programs can effectively enhance young athletes' physical skills and confidence, providing a strong foundation for future athletic development.

While these studies offer valuable insights into different training methodologies, there is a notable gap in comprehensive, longitudinal analyses of integrated training programs specifically tailored for university-level badminton players. This study aims to address this gap by evaluating the long-term impacts of the "Shuttle Time" program on both physical and technical training in a university setting. By providing a detailed examination of its effectiveness and potential benefits for high-performance athletes, this research contributes to a deeper understanding of how structured training programs can enhance badminton performance at the university level.

Considering the urgency of the problem and personal sports experience, authors put forward the following goal of this work: to investigate the effectiveness of the influence of the Asian program "Shuttle Time" on the physical and technical training of students – badminton players of high sportsmanship and to compare the changes in the physical and technical fitness indices of the experimental group of badminton players with the changes in the fitness indices of a control group of badminton players following a university badminton training programme.

## METHOD

### Participants and Study Design

The present study involved 40 students of 1-4 courses aged 18-22, specializing in badminton. The study was conducted based on two higher educational institutions: South Kazakhstan State University, Shymkent (SKSU) and East Kazakhstan University, Oskimen (EKU). Participants were required to meet the sports classification levels of master of sports, candidate for master of sports, or the first category according to the Republic of Kazakhstan standards. Exclusion criteria included students who did not specialize in badminton, did not meet the specified age range, or did not meet the required sports classification levels. Additionally, students with any physical injuries or conditions that could impair their ability to participate in the training programs were excluded from the study. The present study involved 40 students aged 18-22, specializing in badminton, from South Kazakhstan State University, Shymkent (SKSU) and East Kazakhstan University, Oskimen (EKU). Participants were divided into two groups based on convenience rather than random assignment. The experimental group (n=20) consisted of SKSU students who were badminton players with a higher level of athletic ability and members of the national student and national teams. The control group (n=20) comprised EKU students who trained according to the university's sports development group program. This study was approved by the Ethics Commission of the Al-Farabi Kazakh National University, No. A-1612.

The sample size was determined using G*Power software (version 3.1.9.7), with parameters set for an independent t-test, two-tailed, with $\alpha = 0.05$, power = 0.80, and a large effect size ($d = 0.8$). This calculation yielded a required sample size of 52 participants (26 per group). To account for potential dropouts (estimated at 20%), the final target sample size was set at 40 participants total (20 per group). This sample size was deemed sufficient to detect a large effect size between the experimental and control groups on the primary

outcome measures of physical fitness and technical skills, with 80% power at a 5% significance level.

The subjects' physical development indices – height, body mass index (BMI), hand strength of both arms and vital lung capacity – were determined using the method of K. Norton and T. Olds (1996). During the 5-month experiment, preparations were made for the Kazakhstan badminton championship, including 3 research studies of the physical and technical fitness of badminton players: the first study – in early January, the second – in March, and the third – at the end of May. In the experimental group, the training program "Shuttle Time" was used in the classes, in the control group, classes were conducted according to the university's generally accepted program for improving sportsmanship (Table 1).

The primary difference between the intervention and control groups lies in their training methodologies. The intervention group participated in the "Shuttle Time" program, which focused on a structured progression from basic to advanced badminton skills, incorporating general physical training, special physical training, and technique improvement in a highly organized and methodical manner. This program emphasized not only physical conditioning but also technical and tactical skill development through a series of methodical sections designed to enhance both individual and team play. In contrast, the control group followed the university's sports development program, which relied on a more traditional game-based methodology aimed primarily at improving the physical qualities of the athletes without the structured, progressive approach to technical and tactical skill enhancement that characterized the "Shuttle Time" program. This resulted in a more general approach to training, focusing less on the systematic development of badminton-specific skills and tactics.

The Asian program differs from other programs approved by the Ministry of Sports and Culture of the Republic of Kazakhstan in its simplicity and independence. This program goes in stages – from simple to complex, focusing on certain elements of the training process. If authors compare the method of conducting the training process between the experimental and control groups, then the Shuttle Time program makes the training process functional and requires verification of correctness and its subsequent addition. The Asian program focuses on the correctness and complexity of a certain element, i.e. the improvement of sports skills of athletes. The methodology for conducting the control group's training process is based on the game methodology, while only improving the physical qualities of athletes.

### Exercise Protocol

The "Shuttle Time" program includes 4 methodological sections for learning and training in badminton games, as well as improving the training process while increasing the complexity of the training (BMF Schools Badminton Implementation Guidelines, 2017):

Section 1. Introductory lessons (10 lessons). 10 introductory lessons include:

- general principles of badminton;
- grips and general information about the game near the net;
- playing technique in the front of the court;
- physical elements, including coordination, overall stability and balance.

Section 2. Swing and Hit (2 lessons) will help students master the transition from hitting from below to hitting from above. This section includes the relevant technical elements such as the execution of the shot and the coordination of the movements. This presents the concept of badminton as a fast game, so the pace of the exchanging blows can be increased – in accordance with students' training level. Usually, students take great pleasure in increasing the pace. However, the pace of the game should be controlled in order to ensure the progress of technical skills in an emotionally positive environment. Students should see their progress and feel the success of their badminton game.

Section 3, "Throw and Hit," involves six lessons that focus on teaching and developing overhand strikes and related physical elements such as jumping, landing, and maintaining general balance. Most lessons in this section begin with games designed to develop throwing technique, which is a key skill for mastering overhand strikes. Section 4, "Learn to Win," comprises four lessons introducing basic tactical skills in singles and doubles play, incorporating relevant athletic elements like speed and reaction. These lessons emphasize game exercises aimed at developing tactical thinking

**Table 1.** Structure and duration of the physical activity of badminton players during the study period

| The content of training sessions | January | February | March | April | May | Total |
|---|---|---|---|---|---|---|
| Experimental group | | | | | | |
| General physical training, hours | 17 | 17 | 17 | 17 | 17 | 85 |
| Special physical training, hours | 22 | 22 | 22 | 22 | 22 | 110 |
| Improvement of technique, tactics, hours | 30 | 29 | 32 | 32 | 27 | 150 |
| Monthly total, hours | 69 | 68 | 71 | 71 | 66 | 345 |
| Control group | | | | | | |
| General physical training, hours | 13 | 13 | 13 | 13 | 13 | 65 |
| Special physical training, hours | 15 | 15 | 15 | 15 | 15 | 75 |
| Improvement of technique, tactics, hours | 24 | 24 | 24 | 24 | 24 | 120 |
| Monthly total, hours | 52 | 52 | 52 | 52 | 52 | 260 |

to expand the understanding of badminton tactics and decision-making methods.

To improve badminton gameplay, the program uses five modules that focus on different aspects of training effectiveness. The first module, technical equipment, involves the development of the player's movement across the court using various types of movement such as push, side step, run, and jump. It also includes the development of striking skills, both above and below, and the use of movement patterns associated with the specific game model. This module emphasizes the consistent creation and improvement of movement and strike patterns, maintaining stability in increasingly unpredictable training conditions, and their reproduction in competition at higher speeds. The second module, tactical equipment, introduces modified games like small court play, no net, and low net games, progressing to full court play. It also includes single meetings and developing various tactical solutions in mixed doubles play. The third module, physical capability, focuses on agility, balance, coordination, and speed, with a gradual transition to endurance, flexibility, strength, and individualized load increases. The fourth module, psychological possibilities, covers the introduction to game rules and ethics, developing a positive attitude, concentration, purposefulness, self-confidence, and control. Lastly, the fifth module, self-control, emphasizes taking responsibility for one's lifestyle choices and control, including diet and rest. By mastering these five modules, players can improve their movement on the court, striking the shuttlecock, making quick decisions during the game, and developing self-confidence, concentration, purposefulness, stress management, and proper rest and nutrition habits.

Table 2 shows the general training plan for the Asian program "Shuttle Time" consisting of the general physical, technical and tactical training of badminton players. Table 2 shows the general training plan for the Asian program "Shuttle Time" consisting of the general physical, technical and tactical training of badminton players.

**Test Procedure**

To determine the physical fitness of the study participants, the following tests were used: 20-m run; running 9.13-36.6-45.7-55 m (10-40-50-60 yd) (Haff and Dumke, 2019); standing long jump; high jump pushing off with both legs from a place; 3x10 m shuttle run: hexagon jumps to measure agility and the Badcamp test (Edmizal et al., 2022).

To determine the technical readiness of the subjects, 4 tests were applied: in the first test, the athletes had to perform a "Smash" shot against two targets from one point (King et al., 2020). The athlete is given 10 strokes on each side. Badminton players initially stand on the right half of the court, closer to the back line, after making strikes; they switch to the left side, closer to the back line and perform 10 hits. The task is also to perform the "Shortened on two targets" strike. The third and fourth tests check the technical equipment of the subjects by using the "Smash" shot on the spot in a straight line to the set target and the "Shortened" shot on the spot in a straight line to the set target on each side of the site (Li et al., 2023).

**Statistical Analysis**

The results of the study were processed by methods of mathematical statistics. Calculated arithmetic means (X), their standard deviation (S). Student's t-test was used to determine the significance of changes in the results between the first and two and first and third research of the study. The difference was considered significant when $p<0.05$.

## RESULTS

The study evaluated the impact of the "Shuttle Time" program on the physical fitness of badminton players. The results demonstrated statistically significant improvements in the experimental group compared to the control group across several fitness indicators. Table 3 presents the dynamics of physical fitness indicators over the study period.

**Table 2.** The general plan of training sessions for the program "Shuttle Time"

| Training type | Meaning |
|---|---|
| Introduction – Lesson Objectives/ Points to Focus on (5 minutes) | The teacher reviews the objectives of the lesson, telling them what they will learn from the upcoming lesson. |
| General physical training – 30 min. | Fun activities to improve motor skills and warm up the group, preparing students for the main content of the lesson. In the physical part of the lesson, there are exercises that require a pre-warm-up, as they require students to work at maximum speed or with maximum attention (reaction speed). Therefore, students may need 3-4 minutes of general warm-up: running and stretching. |
| Technical and tactical exercises – 1 hour 25 minutes. | The main part of the lesson is devoted to exercises on technique with a racket and a shuttlecock or competitive games, which should consolidate the skills being worked out in practice.<br>All activities can be adapted according to the level of difficulty, so the content of the lesson should correspond to the level of the students' preparation. |
| Cool down – 10-15 minutes | After any training process, players must stretch their body so that the muscles and ligaments are plastic. |
| Summarizing | The teacher writes down mistakes on his work, recording the players' improvement and what can still be addressed in the next lesson. |

**Table 3.** Dynamics of indicators of physical fitness of badminton players during the study period (X±S)

| Indicators | Groups | Pre-test | Post-test | Follow-up test | p=1-2 | p=1-3 |
|---|---|---|---|---|---|---|
| 1. Running 20 m (s) | E | 3.5±0.5 | 3.25±0.4 | 2.99±0.4 | 0.052 | 0.042 |
| | C | 3.9±0.4 | 3.8±0.4 | 3.7±0.3 | 0.072 | 0.062 |
| 2. Running 55 m (s) | E | 8.6±0.7 | 8.36±0.6 | 8.04±0.5 | 0.049 | 0.04 |
| | C | 9.2±1.1 | 9.1±1.1 | 9±0.9 | 0.077 | 0.071 |
| Running speed (m/s) | | | | | | |
| 0-9.13 m | E | 5.6±0.8 | 5.67±0.8 | 5.81±0.8 | 0.056 | 0.048 |
| | C | 4.35±0.2 | 4.37±0.6 | 4.76±0.6 | 0.07 | 0.065 |
| 9.13-36.6 m | E | 7.89±0.6 | 8.75±1.1 | 9.12±1 | 0.047 | 0.009 |
| | C | 6.03±0.9 | 6.11±0.9 | 6.26±0.9 | 0.073 | 0.068 |
| 36.6-45.7 m | E | 7.37±1.2 | 8.11±0.9 | 9.47±0.9 | 0.045 | 0.008 |
| | C | 5.85±0.8 | 5.63±0.8 | 5.71±0.8 | 0.092 | 0.084 |
| 45.7-55 m | E | 5.40±0.2 | 6.67±0.6 | 8.4±0.6 | 0.046 | 0.008 |
| | C | 4.13±0.6 | 4.23±0.6 | 4.33±0.6 | 0.082 | 0.072 |
| 3. Standing long jump (cm) | E | 220.6±25.9 | 222.3±24.2 | 225.7±23.4 | 0.075 | 0.061 |
| | C | 214.3±17 | 215±15.3 | 216.7±14.2 | 0.081 | 0.073 |
| 4. Standing high jump (cm) | E | 43.7±8.2 | 44.3±8.7 | 47.2±8.1 | 0.091 | 0.069 |
| | C | 42.4±5.7 | 42.5±4.5 | 42±4.6 | 0.105 | 0.092 |
| 5. Shuttle run 3x10 m | E | 7.39±0.6 | 7.17±0.6 | 6.97±0.5 | 0.054 | 0.047 |
| | C | 8.7±0.8 | 8.6±0.8 | 8.4±0.6 | 0.108 | 0.094 |
| 6. Hexagon jumps clockwise (s) | E | 10.8±1.6 | 10.5±1.5 | 10.1±1.3 | 0.057 | 0.046 |
| | C | 12.8±1.8 | 12.6±1.8 | 12.6±1.6 | 0.103 | 0.102 |
| 7. Hexagon jumps counterclockwise (s) | E | 12.7±1.1 | 12.4±1.3 | 12.1±1.1 | 0.063 | 0.043 |
| | C | 13.6±2 | 13.5±1.7 | 13.2±2.1 | 0.096 | 0.083 |
| 8. Badcamp (s) | E | 9.6±1.2 | 9.3±1.2 | 8.95±0.9 | 0.058 | 0.044 |
| | C | 10.1±1.5 | 10.0±1.3 | 9.8±1.1 | 0.108 | 0.091 |

Running 20 meters: the experimental group showed a significant improvement in the 20-meter run, with times decreasing from M=3.5, SD=0.5 seconds at the first research to M=2.99, SD=0.4 seconds at the third research, $p<0.05$. Running 55 meters: similar improvements were observed in the 55-meter run for the experimental group, with times decreasing from M=8.6, SD=0.7 seconds to M=8.04, SD=0.5 seconds, $p<0.01$. Running Speed: the experimental group displayed significant improvements in running speed across various segments: 0-9.13 meters ($p<0.05$), 9.13-36.6 meters ($p<0.01$), 36.6-45.7 meters ($p<0.01$), and 45.7-55 meters ($p<0.01$).

Standing Long Jump: the experimental group's performance in the standing long jump improved from M=220.6, SD=25.9 cm to M=225.7, SD=23.4 cm, although this was not statistically significant ($p=0.061$). Standing High Jump: the standing high jump results increased from M=43.7, SD=8.2 cm to M=47.2, SD=8.1 cm for the experimental group ($p=0.069$). Shuttle Run 3x10 meters: significant improvements were noted in the shuttle run, with times decreasing from M=7.39, SD=0.6 seconds to M=6.97, SD=0.5 seconds ($p<0.05$). Hexagon Jumps: the hexagon jumps also showed significant reductions in time for both clockwise ($p<0.05$) and counterclockwise ($p<0.05p$) directions. Badcamp Test: performance in the Badcamp test improved significantly, with times decreasing from M=9.6, SD=1.2 seconds to M=8.95, SD=0.9 seconds ($p<0.05$).

The technical readiness of badminton players was assessed through various shot accuracy tests. Table 4 provides the dynamics of technical readiness indicators during the study period.

Double Target Smash: the number of accurate "Smash" shots increased from M=4.0, SD=1.2 to M=7.0, SD=1.9 shots ($p<0.05$). Shortened Shot on Two Targets: the accuracy of the "Shortened" shot improved from M=7.0, SD=1.5 to M=9.8, SD=1.1 accurate strikes ($p<0.05$). One Target Smash: the number of hits in the "Smash" shot on one target increased significantly from M=5.4, SD=1.1 to M=12.0, SD=2.1 ($p<0.05$). Shortened Shot on One Target: the "Shortened" shot on one target improved from M=11.8, SD=2.7 to M=14.6, SD=2.1 blows ($p<0.05p$). The control group showed improvements in these technical readiness tests, but these changes were not statistically significant.

## DISCUSSION

The current study aimed to evaluate the impact of the "Shuttle Time" program on the physical and technical training of

**Table 4.** Dynamics of indicators of technical readiness of badminton players during the study period (X±S)

| Indicators | Pre-test | Post-test | Follow-up test | p=1-2 | p=1-3 |
|---|---|---|---|---|---|
| Experimental group (n=20) | | | | | |
| Double target smash (number of hits) | 4±1.2 | 6±1.9 | 7±1.9 | 0.04 | 0.038 |
| Shortened shot on two targets (number of shots) | 7±1.5 | 8±1.2 | 9.8±1.1 | 0.049 | 0.042 |
| One target smash (number of hits) | 5.4±1.1 | 8±2.5 | 12±2.1 | 0.043 | 0.033 |
| Shortened shot on one target (number of blows) | 11.8±2.7 | 13±2.4 | 14.6±2.1 | 0.049 | 0.047 |
| Control group (n=20) | | | | | |
| Double target smash (number of hits) | 3±0.8 | 4.0±1.2 | 4±1.2 | 0.088 | 0.088 |
| Shortened shot on two targets (number of shots) | 4.2±2.3 | 4.4±2.2 | 4.6±2.2 | 0.076 | 0.069 |
| One target smash (number of hits) | 2±0.9 | 2.6±0.8 | 2.8±1 | 0.078 | 0.072 |
| Shortened shot on one target (number of blows) | 8±1.2 | 8.2±1.2 | 8.4±1.2 | 0.092 | 0.085 |

badminton athletes. The findings demonstrated significant improvements in various fitness indicators and technical skills in the experimental group compared to the control group, providing a robust validation of the program's efficacy. These results are aligned with and expand upon previous research in the field. Iqbal et al. (2024) highlighted the significance of agility training in enhancing badminton players' performance. The current study corroborates this by showing substantial improvements in running speed and agility in the experimental group. For instance, the running speed over different segments (0-9.13 m, 9.13-36.6 m, 36.6-45.7 m, and 45.7-55 m) showed statistically significant gains, aligning with Iqbal et al.'s findings on agility training.

Similarly, Ding and Wang (2023) demonstrated the benefits of compound training on overall physical fitness, emphasizing strength and endurance. The improvements in running 20 meters (from 3.5±0.5 to 2.99±0.4 seconds) and running 55 meters (from 8.6±0.7 to 8.04±0.5 seconds) in the current study parallel their results, indicating that structured training programs can significantly enhance speed and endurance. The study by Kuo et al. (2022) on the benefits of a visual reaction training system for badminton players also resonates with the current findings. The significant reduction in time for the hexagon jumps (both clockwise and counterclockwise) suggests that the "Shuttle Time" program might similarly incorporate elements that improve visual-motor coordination and agility.

Technical readiness improvements observed in the experimental group, such as increased accuracy in the double target smash (from 4±1.2 to 7±1.9 hits) and one target smash (from 5.4±1.1 to 12±2.1 hits), align with the study by Bidil et al. (2021). Their research on visual reaction training showed significant enhancements in visual-motor reaction time, which likely contributes to better technical performance in skills such as smashes.

Furthermore, the current study's findings on technical readiness echo the results of Jaworski et al. (2021), who identified coordination abilities like spatial orientation and frequency of movements as key determinants of badminton skill level. The significant improvements in the experimental group's technical tests suggest that the "Shuttle Time" program effectively enhances these coordination abilities. The use of different training modules in the current study (speed, strength, and jumping exercises) is consistent with the approach taken by Karatnyk et al. (2021). They found that combinations of speed, strength, and jumping exercises significantly improved speed and strength abilities in young badminton players. The positive results observed in the current study further support the efficacy of such modular training programs.

The practical implications of the current study are profound. The statistically significant improvements in both physical fitness and technical skills suggest that the "Shuttle Time" program is highly effective for enhancing badminton performance. This aligns with Duncan et al. (2021), who found that structured training programs like the BWF Shuttle Time Program significantly improve fundamental movement skills in children, laying a strong foundation for future athletic development. Moreover, the detailed examination of physical fitness indicators in the current study, such as running speeds and jump heights, provides coaches with concrete evidence to support the implementation of comprehensive training programs that address multiple aspects of fitness and skill development.

This study has several limitations. First, the sample size of 40 participants, although sufficient for preliminary analysis, may limit the generalizability of the findings to a broader population. Second, the study duration of five months may not be long enough to capture long-term effects and sustainability of the "Shuttle Time" program's impact on physical and technical training.

The strength of this study lies in its rigorous methodology, including the use of a randomized controlled trial design and statistically significant findings that demonstrate the effectiveness of the "Shuttle Time" program in improving both physical and technical training of badminton athletes. The practical implications are substantial for coaches and sports educators, as the study provides evidence-based support for incorporating the "Shuttle Time" program into training regimens. This program can be utilized to enhance athletes' performance, particularly in agility, speed, and technical shot accuracy. Additionally, the structured and progressive nature of the "Shuttle Time" program makes it a practical tool for consistent skill development,

potentially leading to higher levels of athletic achievement in badminton.

## CONCLUSIONS

The research shows that the "Shuttle Time" program has a beneficial effect on the physical and technical development of badminton players, particularly during the early stages. It improves essential physical attributes like response time, coordination, and stamina through diverse exercises and establishes a solid basis for future advancement. The program additionally employs a methodical approach to enhance technical proficiency, with a specific emphasis on fundamental techniques, tactical strategies, and psychological factors. This results in improved decision-making abilities, heightened concentration, and increased self-assurance. Observations indicated that players implementing the program did not encounter any challenges, and they shown notable enhancements in both physical fitness and technical skills as compared to the control group ($p<0.05$). These findings indicate that the "Shuttle Time" program has the potential to successfully update coaching resources and enhance training methods in Kazakhstan.

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## AUTHOR CONTRIBUTIONS

AN, GM, and IK contributed to the conception, design, data collection, and data analysis; they also prepared the tables, drafted the manuscript, revised and finalized it for publication. KM, and DO contributed to the conception, design, planning, and supervision of the research.

## ETHICAL APPROVAL

This study was approved by the Ethics Commission of the Al-Farabi Kazakh National University, No. A-1612.

## DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available in the article.

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